Infiltration: Fitting Into A Stormwater Management Plan

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Post - Construction Stormwater Management Workshop
November - December 2004

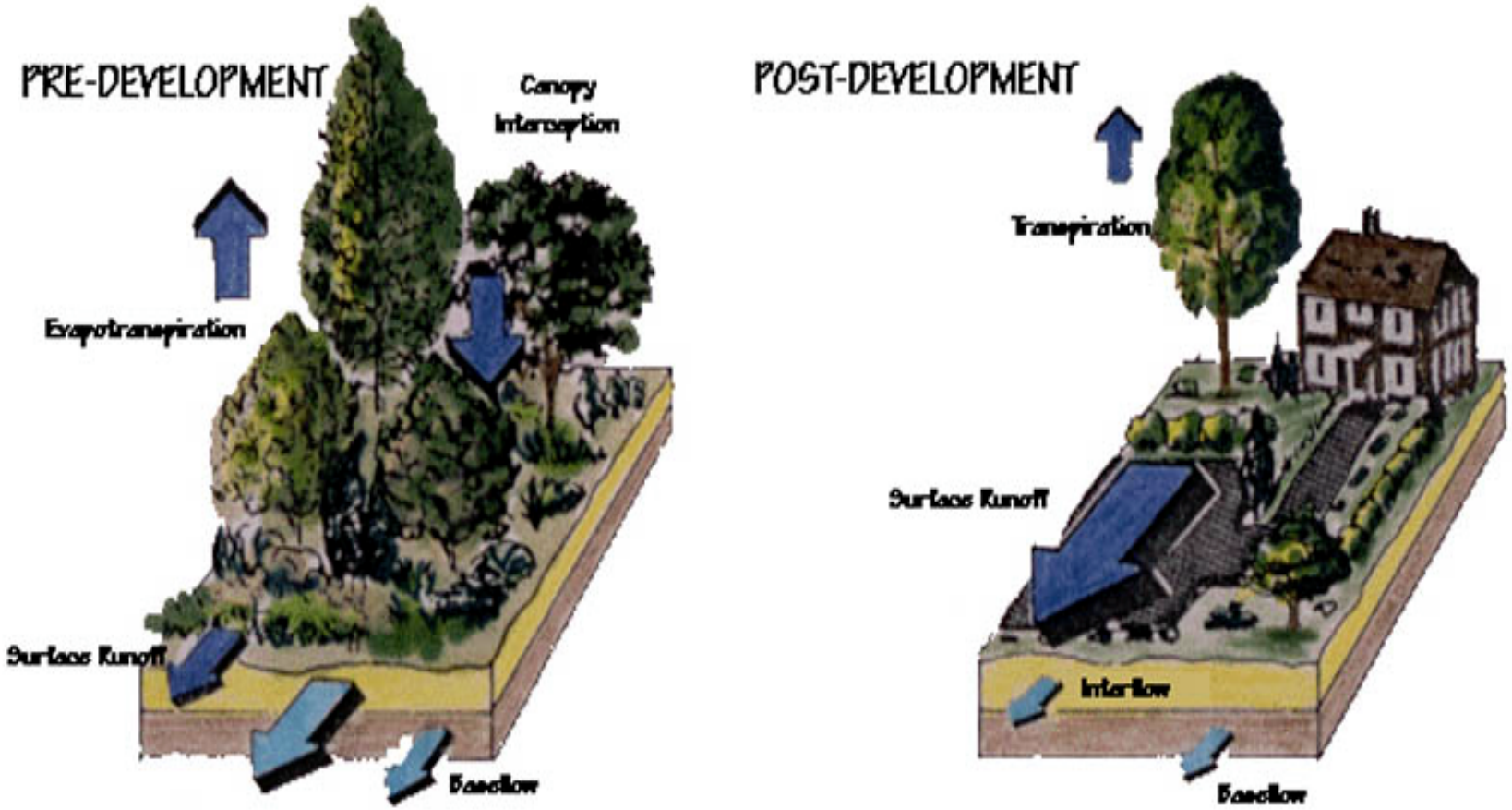
WISCONSIN
DEPT. OF NATURAL RESOURCES

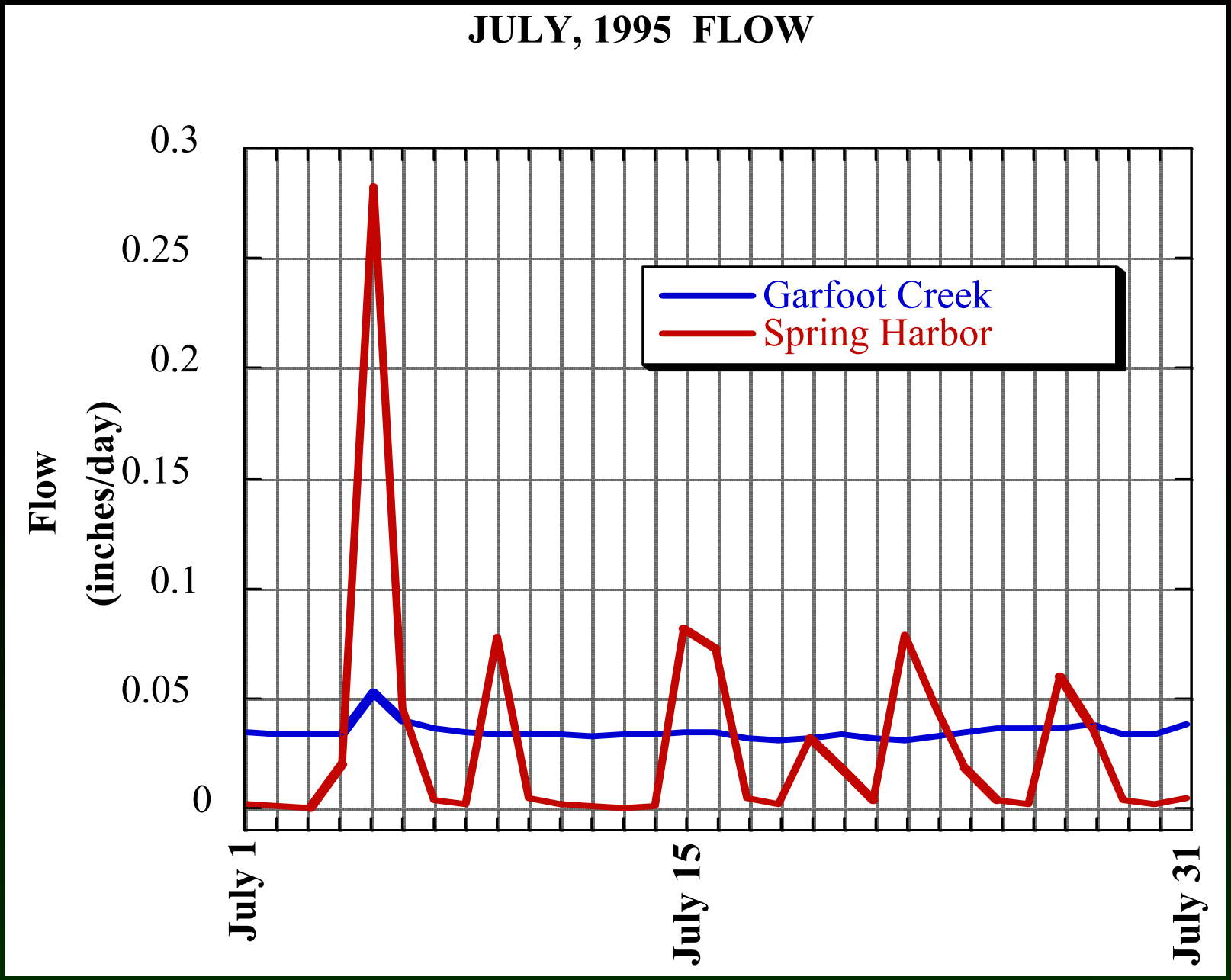
Planning for Infiltration

Roger Bannerman


8 22'95

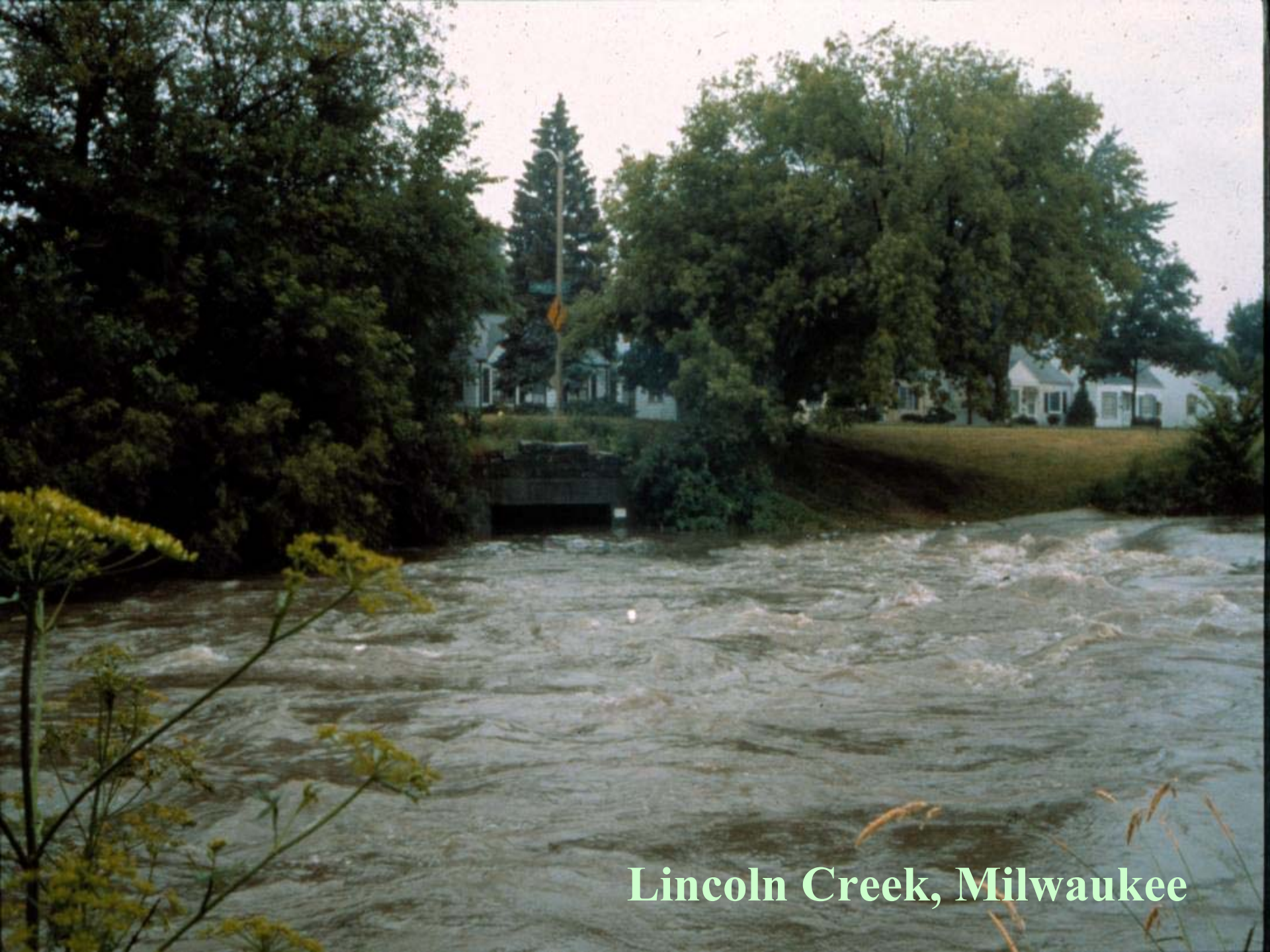
WATER BALANCE



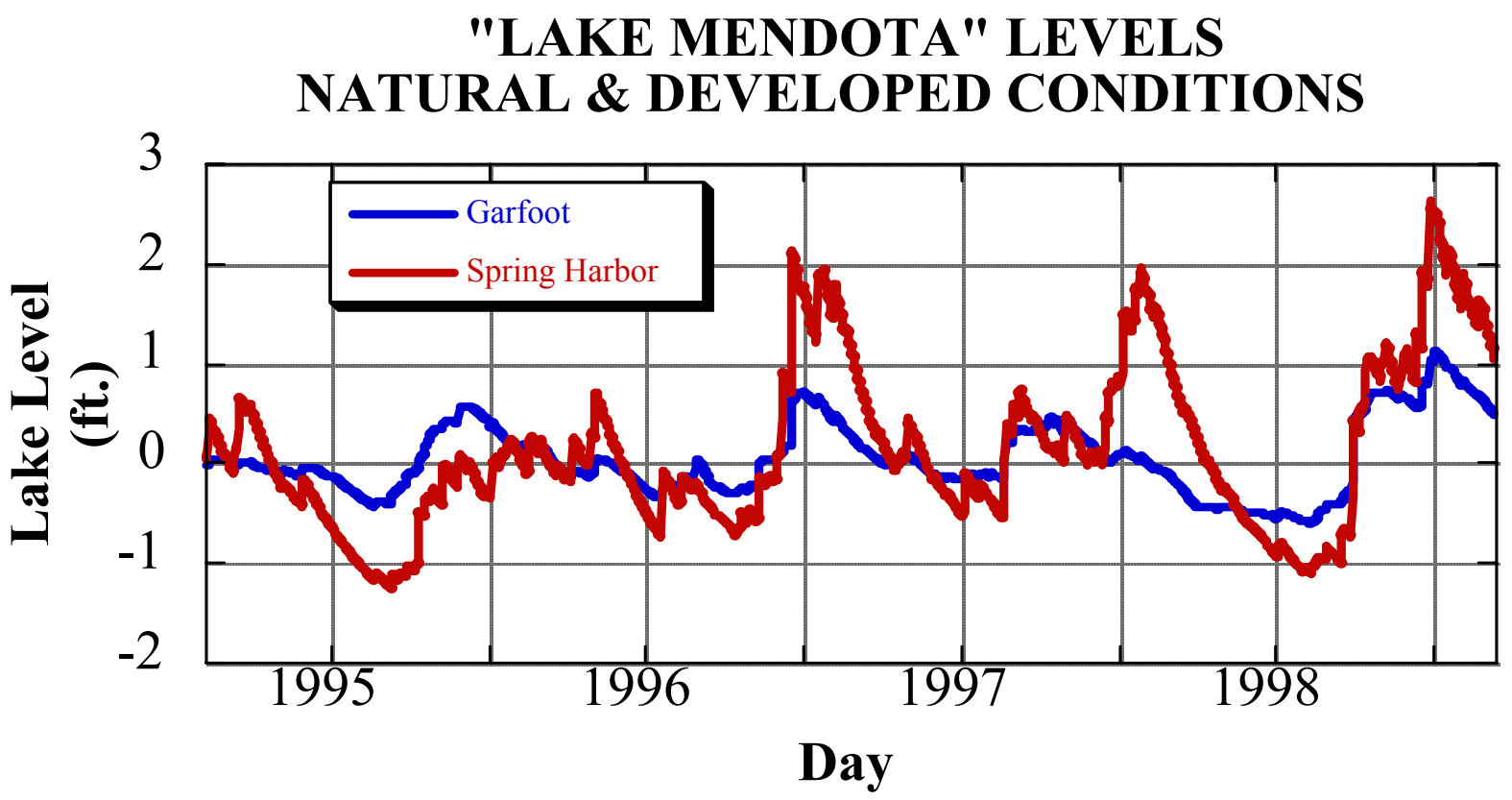

JULY, 1995 FLOW
Flow
(inches/day)
0.3
0.25
0.2
0.15
0.1
0.05
0
Garfoot Creek
Spring Harbor
July 1
July 15
July 31

Lincoln Creek,
Milwaukee - 1996


Lincoln Creek, Milwaukee


Lincoln Creek, Milwaukee

Effects on Lakes



Lake Mendota – Madison Wisconsin


Lake Mendota - 2000

Increases in Urban Runoff for Lake Mendota from 2000 to 2020

- Amounts of Urban Runoff for 2000:

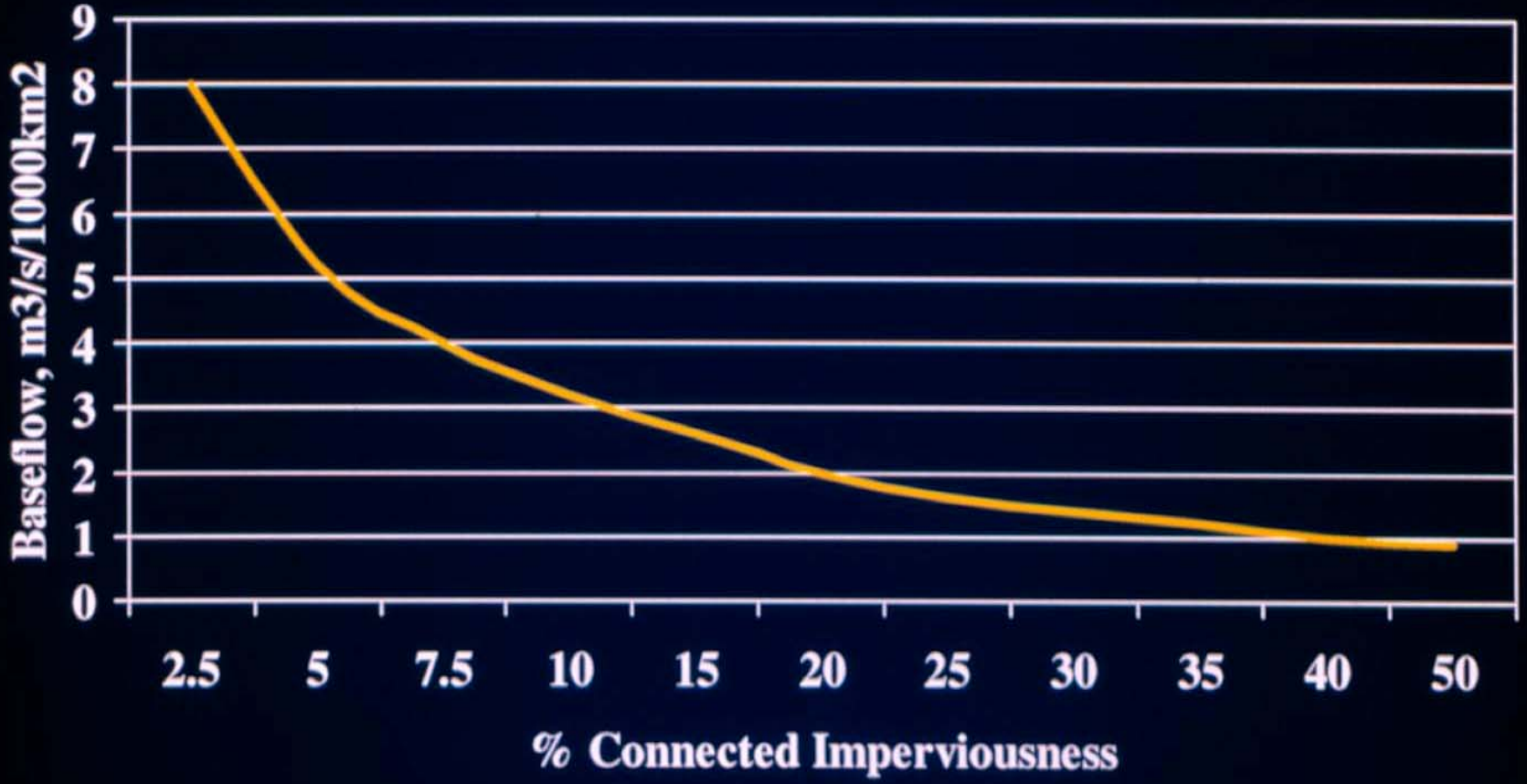
5,600,000,000 gallons
or 17,000 acre-feet

- Amounts of Urban Runoff for 2020:

8,800,000,000 gallons
or 27,500 acre-feet

(Increase of 57%)

Impacts of Urbanization on Stream Baseflows



Predicted Temperature Increase

Lowes Creek, Eau Claire

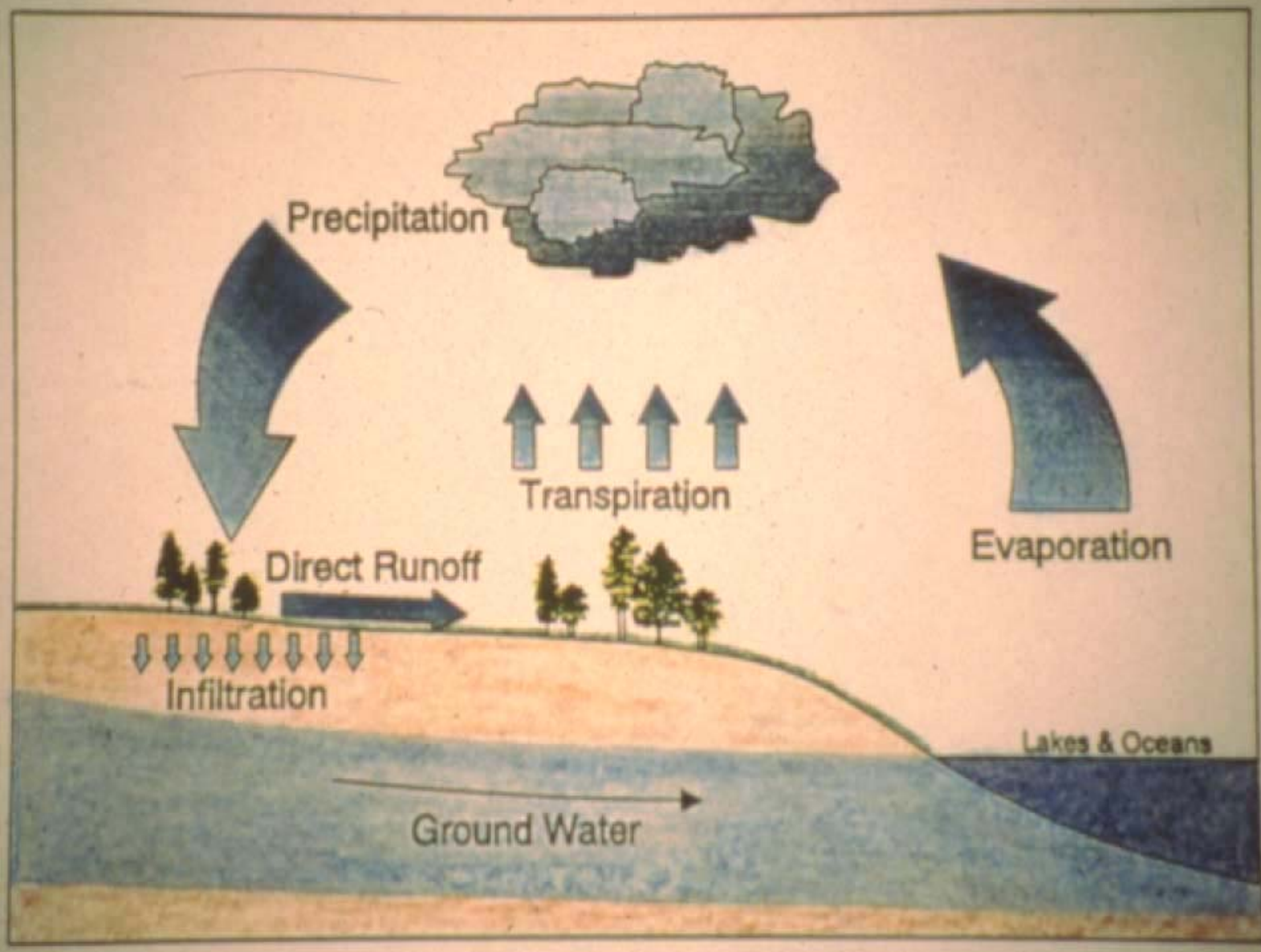
	Mean (°F)	Maximum (°F)
Existing	62	71
Developed (35% Impervious)	67	82

Brown Trout Optimum = 66°F

Impacts of Imperviousness on Surface and Groundwater Quantities

Type of Resource	Increase Imperviousness From 2 to 18%	Increase Imperviousness From 2 to 60%
Stream Baseflow	-20%	Dry Stream
Surface Runoff	+ 90%	+485%
Regional Groundwater Levels	-10%	-55%

The Hydrologic Cycle



Post Construction Infiltration Performance Standards

By design, infiltrate sufficient runoff volume so that the post-development average annual infiltration volume shall be a portion of pre-development infiltration volume.

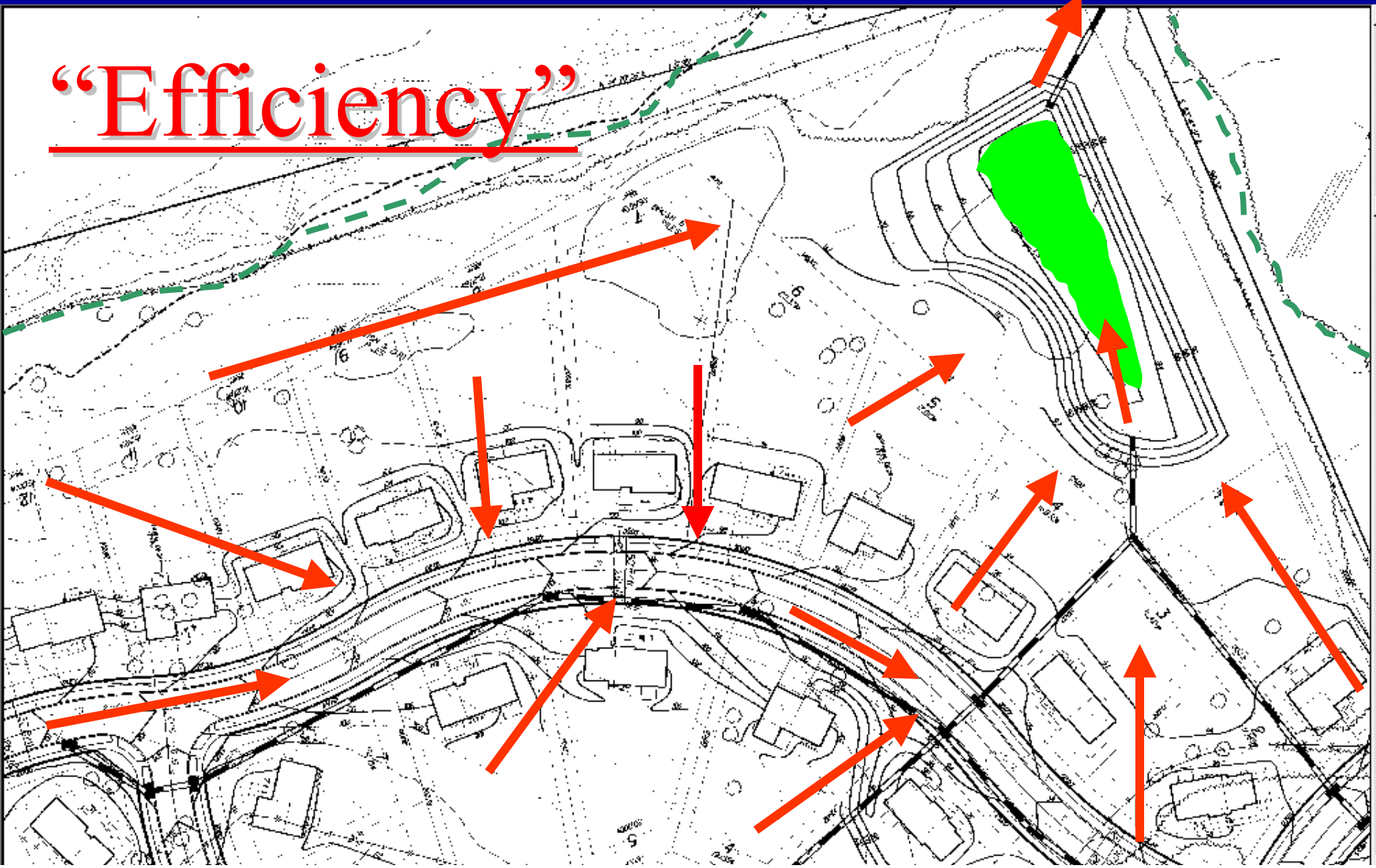
Residential	**Non-residential**
90% (1% Cap)	60% (2% Cap)

The Problem: Conventional Site Design

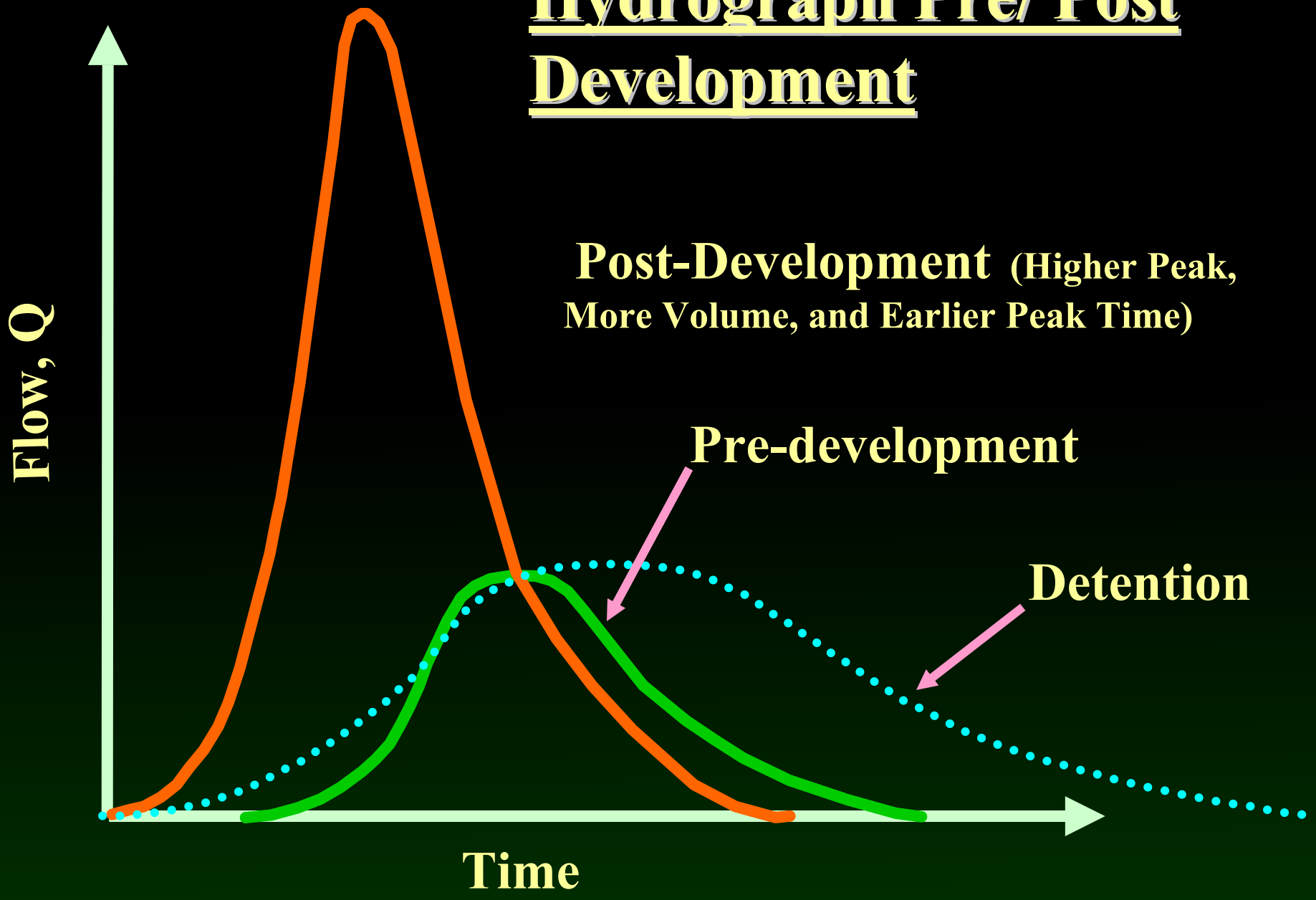
Collect
Concentrate
Convey
Centralized
Control

Good Drainage Paradigm

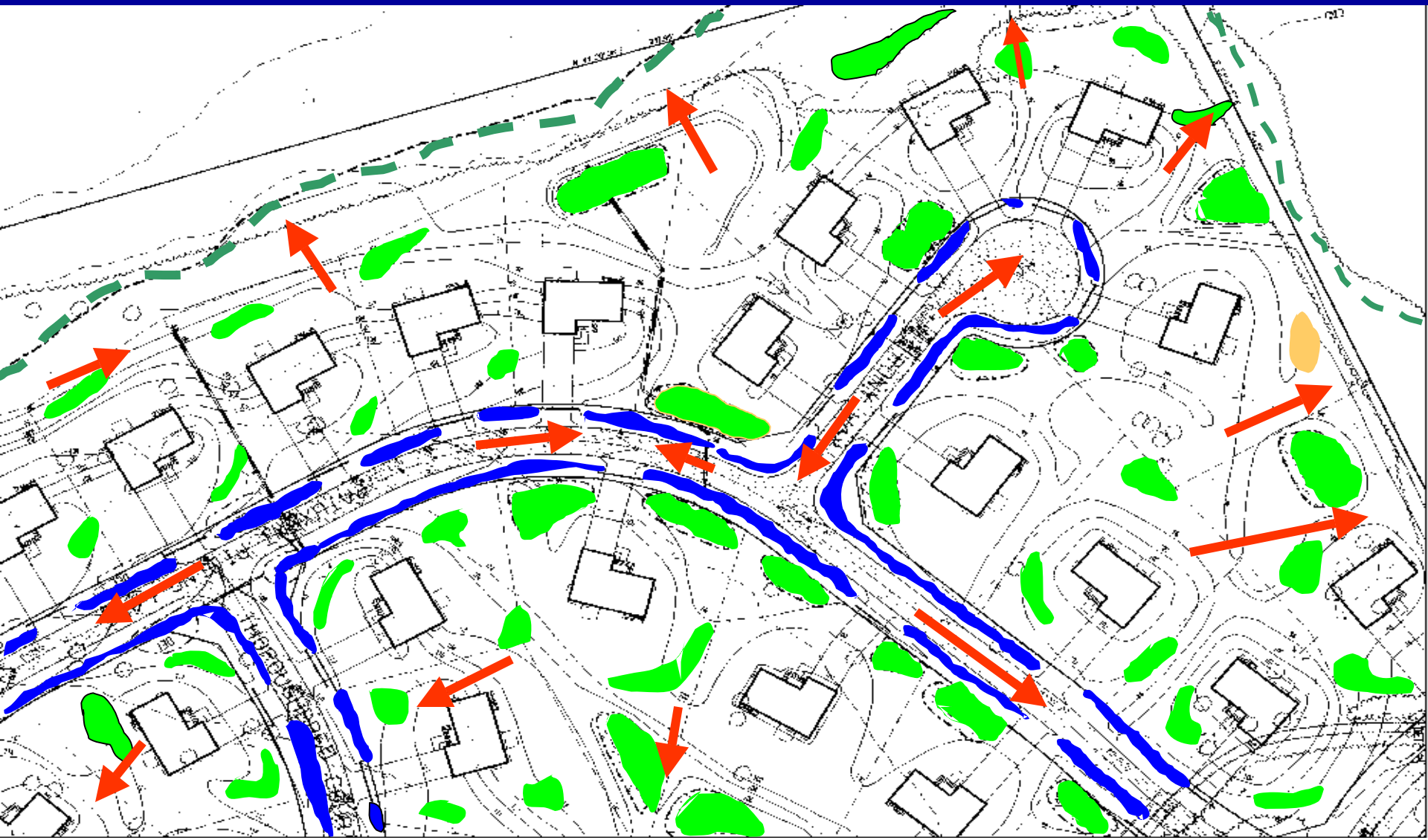
Conventional Pipe and Pond Centralized Control



Hydrograph Pre/ Post Development



Distributed Small-scale Controls



Maintaining Natural Hydrology Functions

Source Area Infiltration

Rooftop Runoff

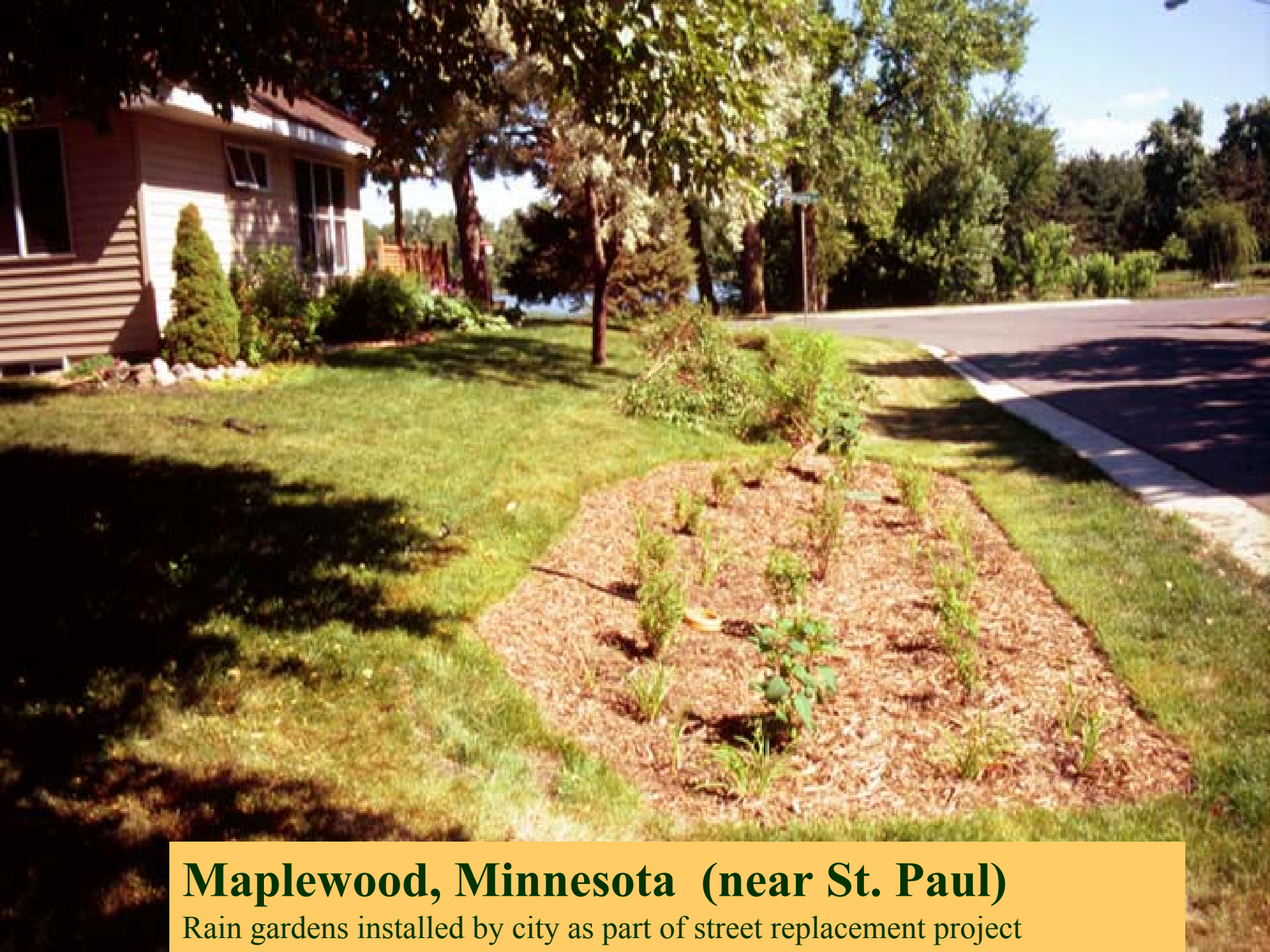

Madison, Wisconsin


Madison, Wisconsin


Willy St. COOP -
Madison, WI

Source Area Infiltration

Street Runoff



Maplewood, Minnesota (near St. Paul)

Rain gardens installed by city as part of street replacement project


Seattle, WA

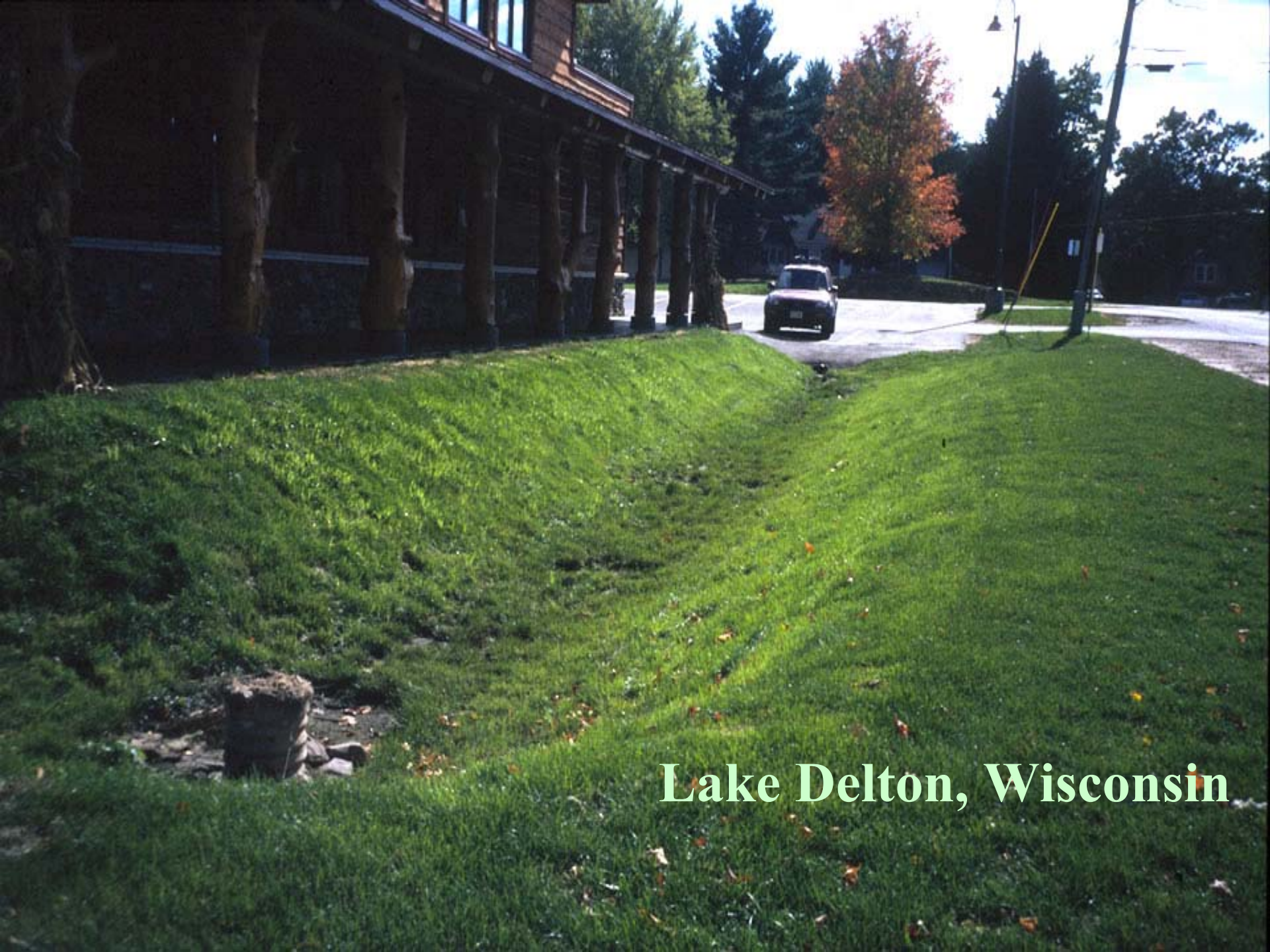
Bioretention –
Lodi, WI; WDOT
(John Voorhees)


Brookfield, WI

Source Area Infiltration

Parking Lots


Cross Plains, WI


Lake Delton, Wisconsin

Edgewood College, Madison

Joel Stocker Photo

JORDAN COVE URBAN WATERSHED PROJECT

Waterford, Connecticut

J. Alexopoulos & J. Clausen

This project is funded in part by the CT DEP through the US EPA
Nonpoint Source grant under § 319 of the Clean Water Act

Site Design

Conservation Design

Figure 5-6
Conventional Development Layout and Stormwater Plan

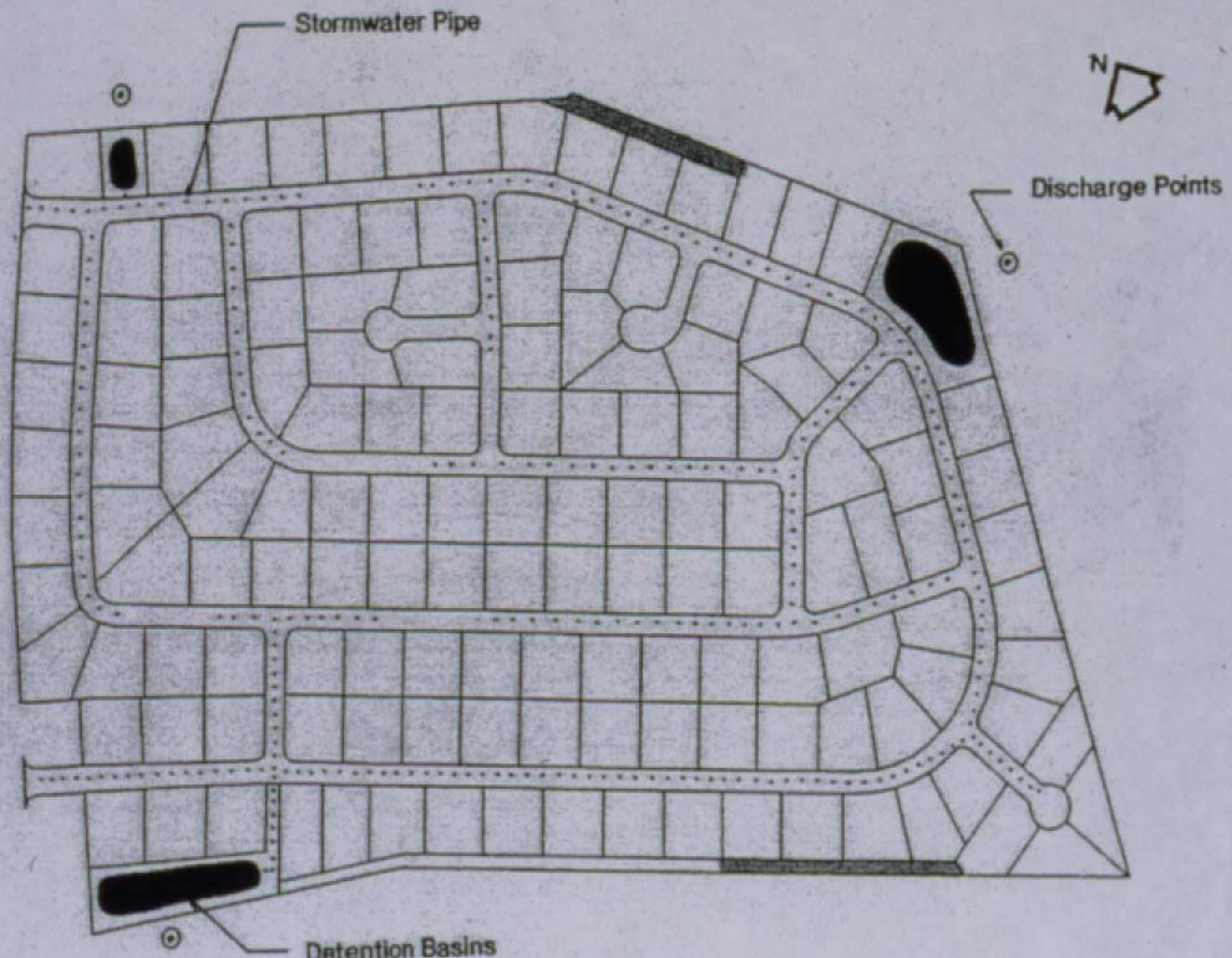
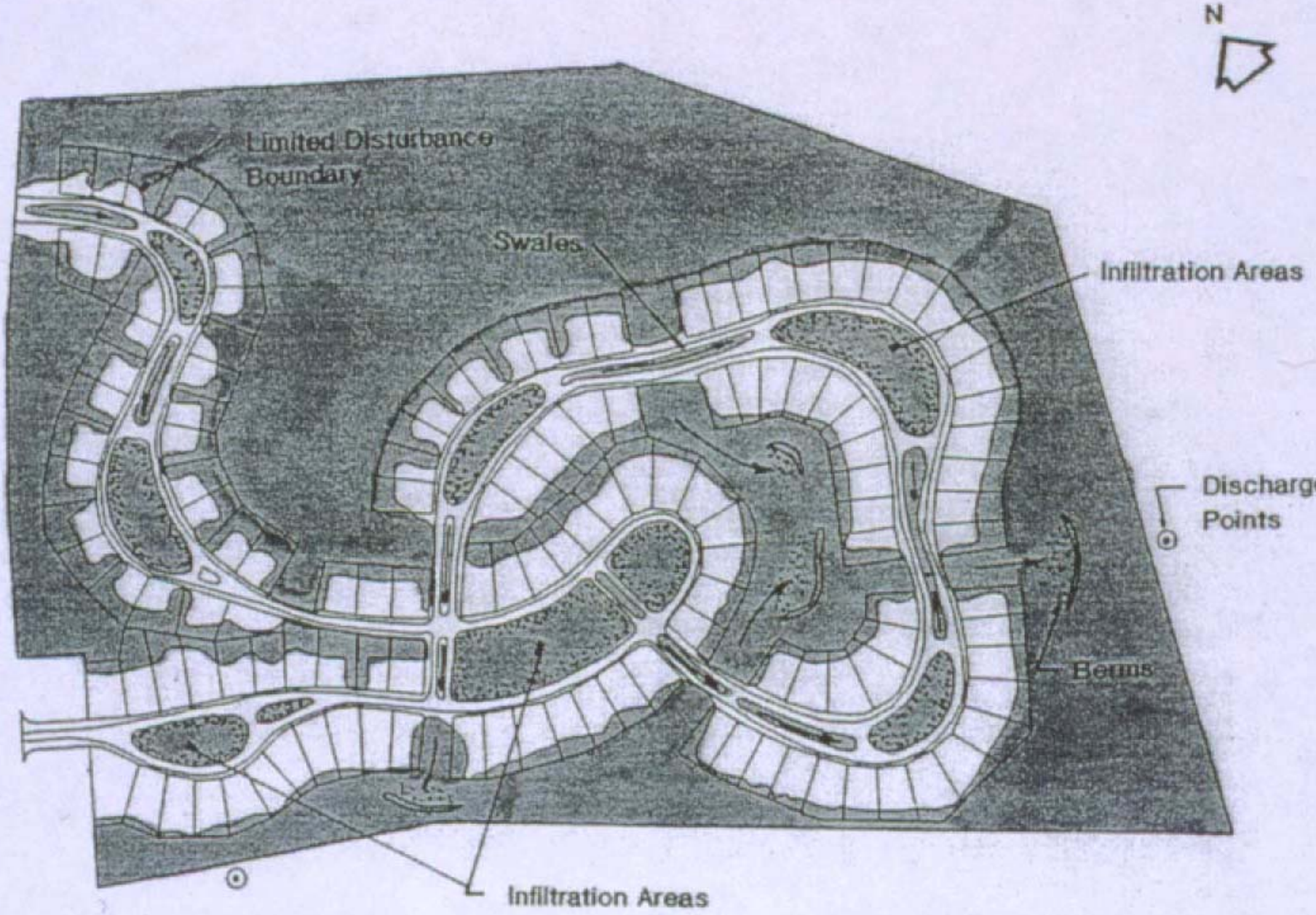
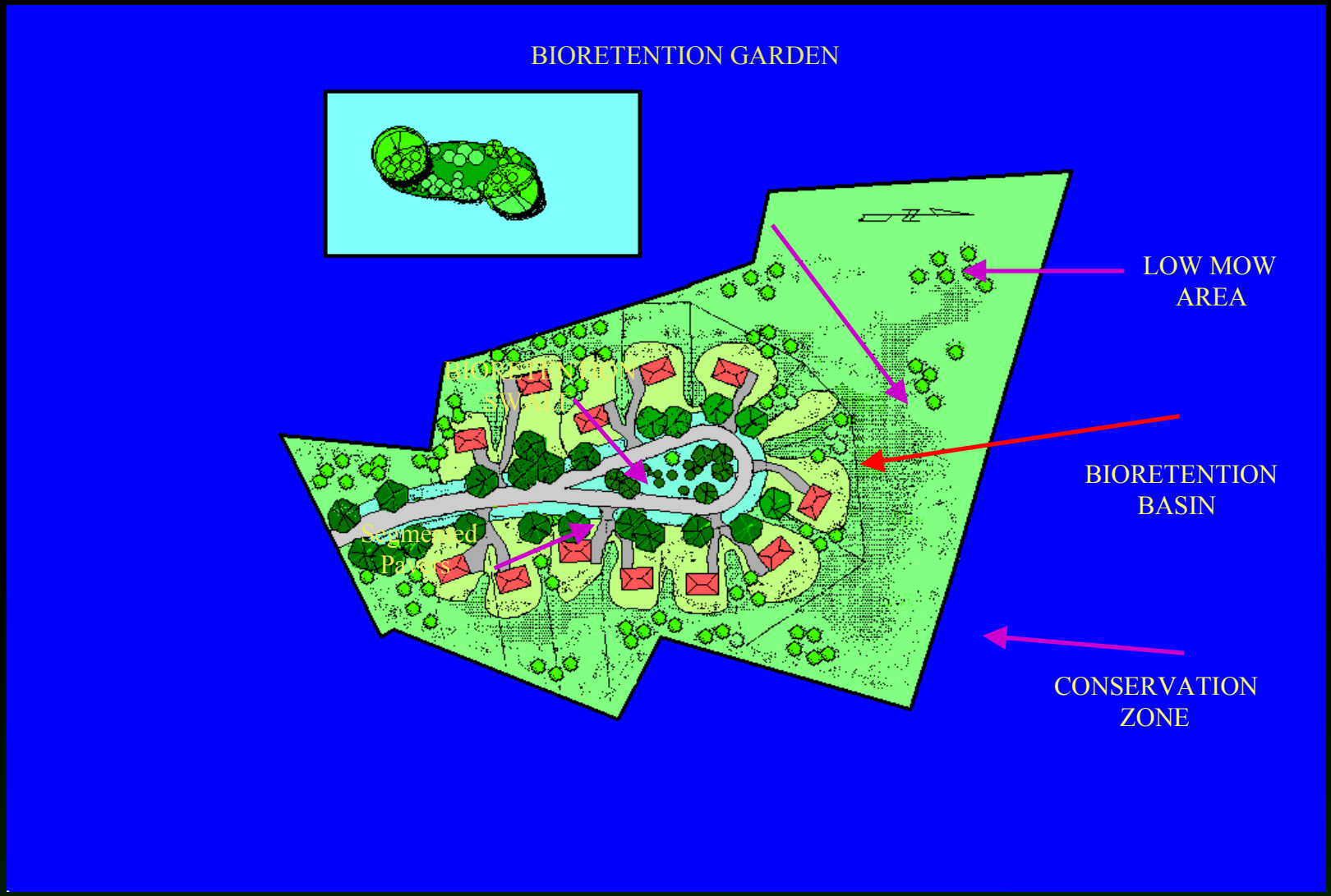


Figure 5-10
Parkway Stormwater Management Plan



Site Design

Low Impact Development



BMP STUDY AREA

JORDAN COVE URBAN WATERSHED PROJECT
Waterford, Connecticut
J. Alexopoulos & J. Clausen
D. Gerwick, Engineering

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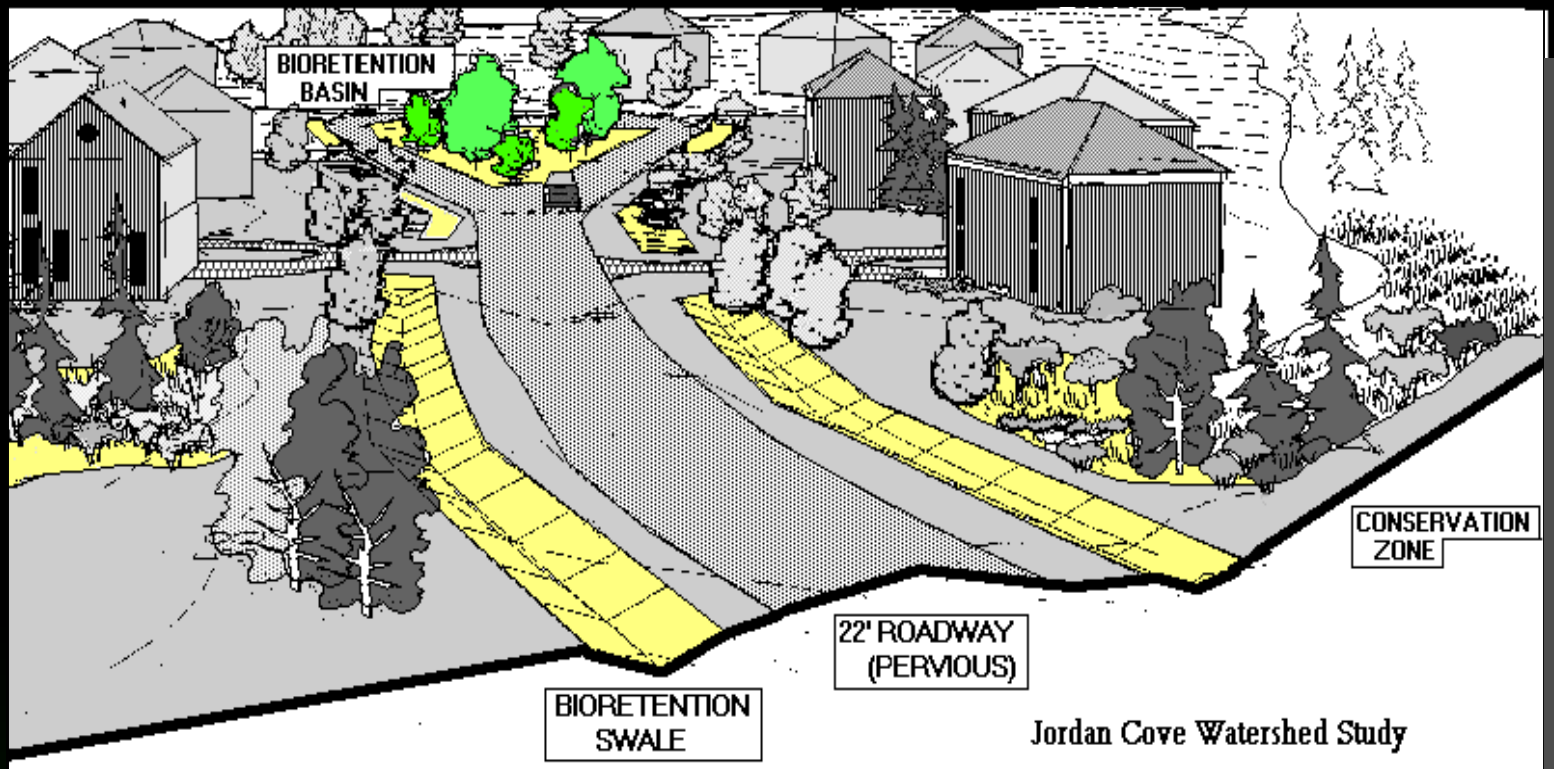

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Stan Zaremba

BIOBASIN

J O R D A N C O V E U R B A N W A T E R S H E D P R O J E C T
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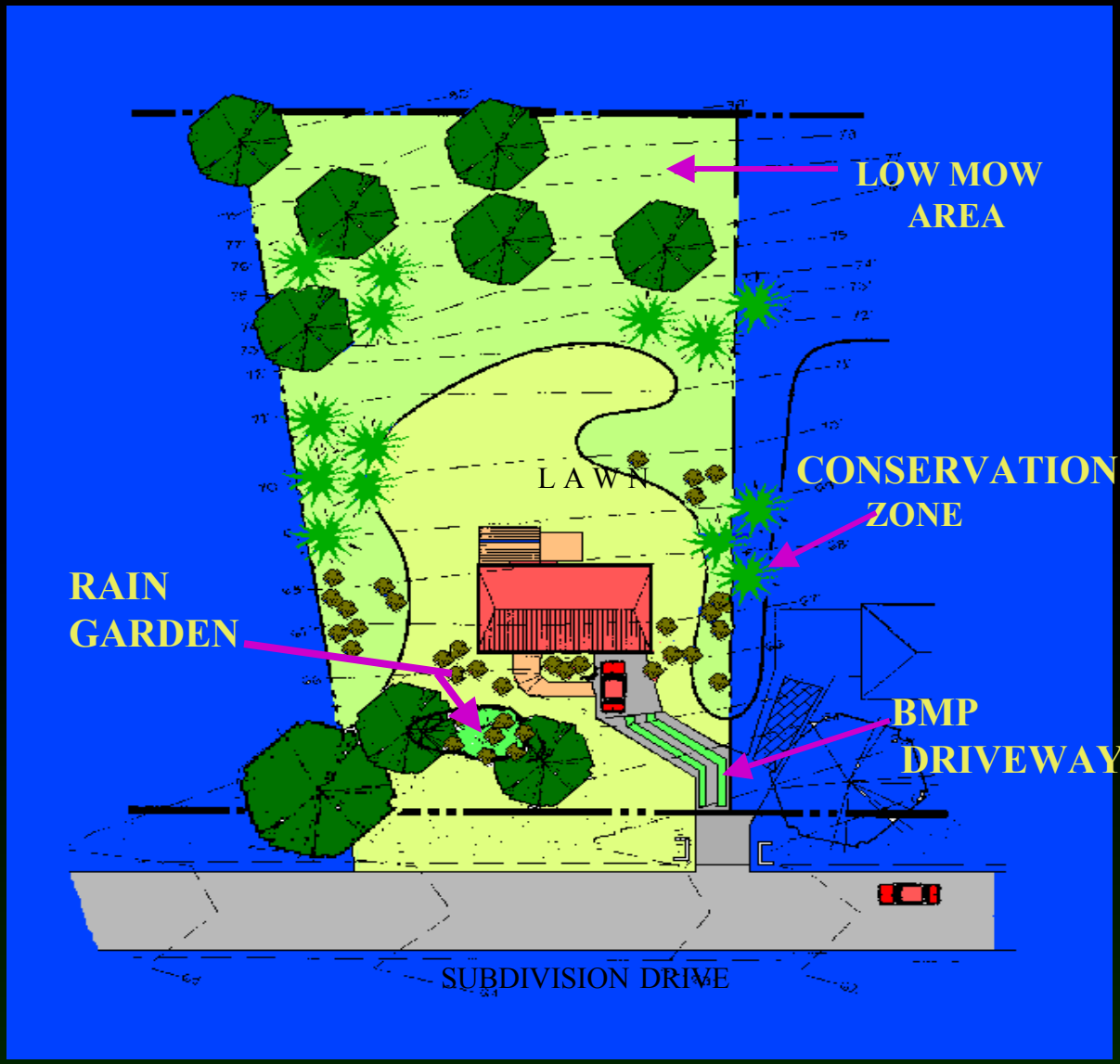
TYPICAL HOME LOT



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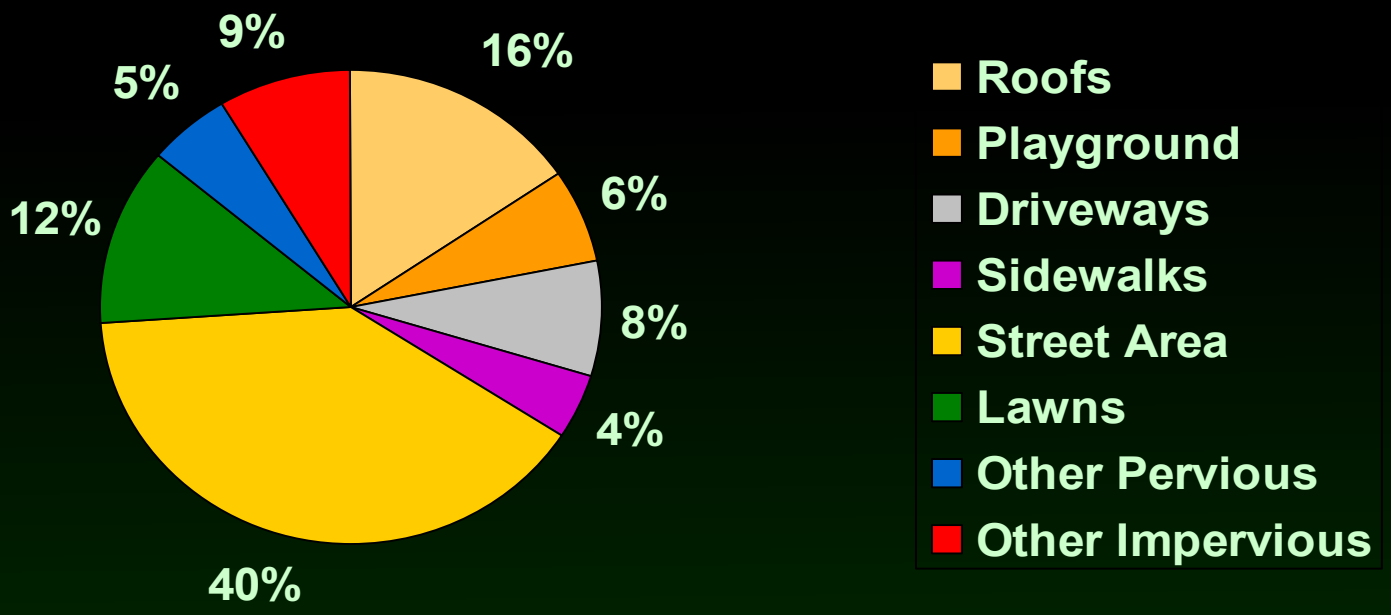
Brewery Creek, WI


St Francis
Development –
Cross Plains, WI

% Annual Runoff Volume by Source Area for St Francis



Elements of Low Impact Design for St. Francis Development

- Rain Gardens
- Infiltration Trenches in Street Boulevards
- Two Regional Infiltration Basins
- Protection of Riparian Buffer

Steve Apfelbaum: Applied Ecological Services


West Bend, WI

Implementing Infiltration Under Chapter NR 151

John Pfender

NR 151
Post-Construction Standards

Infiltration Standard (by design)

- Residential
  - Infiltrate **90%** average annual predevelopment infiltration volume or
  - **25%** of the 2-year, 24-hour storm
- Non-residential
  - Infiltrate **60%** average annual predevelopment infiltration volume or
  - **10%** of the 2-year, 24-hour storm
- Exclusions for groundwater protection
- Exemptions for practicality reasons

NR 151
Post-Construction Standards

Infiltration Standard (by design)

- Pre-treat parking lots & roads to protect GW and infiltration device

- Maximum effective infiltration area to meet volume requirement
  - Residential: 1% of project site
  - Non-residential: 2% of project site

General Applicability of the Infiltration Standard

- This is a post-construction standard
  - New development
- In general, applies to land disturbances at least 1 acre in size
- There are some places where post-construction standards do not apply

Exceptions to General Applicability of Post-Construction Standards

- Notices of Intent prior to October 1, 2004
  - Includes submittals to DNR or Commerce
- Redevelopment site with no increase in parking lots or roads
- Post-construction site with less than 10% connected imperviousness (unless parking lots plus rooftops > 1 acre)
- Agricultural facilities and practices

Distinguishing the Development Site From the Property

- The performance standard applies only to the area of land disturbance.

- If a site has portions left undisturbed, do not consider these areas when:

  - Determining the required infiltration volume
  - Taking infiltration credit towards the required infiltration volume

Definition:
Effective Infiltration Area

Effective infiltration area: The area of the infiltration system that is used to infiltrate runoff and does not include the area used for site access, berms or pretreatment.

Definition:
Infiltration System

"**Infiltration system**" means

a device or practice such as a basin, trench, rain garden or swale designed specifically to encourage infiltration

Definition:
Infiltration System

"**Infiltration system**" does not include

natural infiltration in pervious surfaces such as lawns, redirecting of rooftop downspouts onto lawns

or

minimal infiltration from practices, such as swales or road side channels designed for conveyance and pollutant removal only.

Maximum required Effective Infiltration Area (EIA)

- Maximum portion of the project site that must be dedicated to EIA
- For residential: 1% of project site
  - Project site is area of land disturbance
- For non-residential: 2% of site
  - Project site is only that portion of land disturbance dedicated to rooftop & parking lot

Example Calculation of Required Maximum EIA: Residential Area

- Property: 40 acres total; 8 acres undisturbed
- Land Disturbance (32 acres total)
  - Building (roof) 5 acres
  - Drive + Sidewalk 2 acres
  - Street 5 acres
  - Lawn 20 acres
- Maximum Required EIA Calculation
  - (32 acres) * 0.01 = 0.32 acres or 13,939 sq. ft.

Example Calculation of Required Maximum EIA: Non-residential Area

- Property: 40 acres total; 1 acre undisturbed
- Land Disturbance (39 acres total)
  - Building roof 11 acres
  - Feeder Street (new) 4 acres
  - Parking Lot 22 acres
  - Sidewalk, utility lanes 1 acre
  - Landscaped area 1 acre
- Maximum Required EIA Calculation
  - (33 acres) * 0.02 = 0.66 acres or 28,750 sq. ft.

Maximum Extent Practicable (MEP)

Definition takes into consideration:

- **Best available technology**
- **Cost-effectiveness**
- **Natural and historic resource protection**
- **Human safety & welfare**
- **Geographic features**
- **Varies based on standard and site conditions**

Maximum Extent Practicable (MEP)

- Even though a performance standard is not fully achievable, it must still be met to the MEP
- Full attainment of a standard is required unless there are unique and site-specific condition(s) that result in MEP being less than full attainment

Additional Factors Affecting MEP for Infiltration

- Site evaluation
  - NR Conservation Practice Standard 1002
- Maximum Effective Infiltration Area
- Major topographic changes not required
- Stormwater pumping not required
- Infiltrate rooftop runoff first
  - Reduces pre-treatment needs

Pre-Development Curve Numbers

- Standard based on pre-development condition
- CN shall assume “good hydrologic condition” as identified in TR-55 or equivalent methodology
- Maximum Cropland Curve Numbers are:

Hydrologic Soil Group	A	B	C	D
Runoff Curve Number	56	70	79	83

Calculating Water Quality Volume

- Standard provides two options:
  - Average annual infiltration method (60-90% of pre-development)
  - Design storm method (10-25% of post-development runoff)

Calculating Water Quality Volume

- DNR recommends average annual method
- Average annual method best represents the state's water quality needs
- Design event approach is a rough approximation of the average annual method. Tends to overestimate infiltration needed to meet state water quality goals

"Disconnecting" Impervious Areas

- Disconnection: "Sheet flow over pervious area of sufficient length to significantly reduce stormwater volume and pollutants
- Conceptually, "disconnection" turns impervious surface into a pervious surface
- Disconnection can be used to help achieve the infiltration goal

"Disconnecting" Impervious Areas

Disconnection is not considered to be part of an infiltration system as defined in NR 151.

Therefore ...

Disconnection areas are not counted towards the maximum effective infiltration area requirement.

"Disconnecting" Impervious Areas

Interim Guidelines for Residential Roofs

- To consider residential roofs as disconnected, the flow path must:
  - Be over a pervious area in good condition
  - Be at least 20' long

"Disconnecting" Impervious Areas

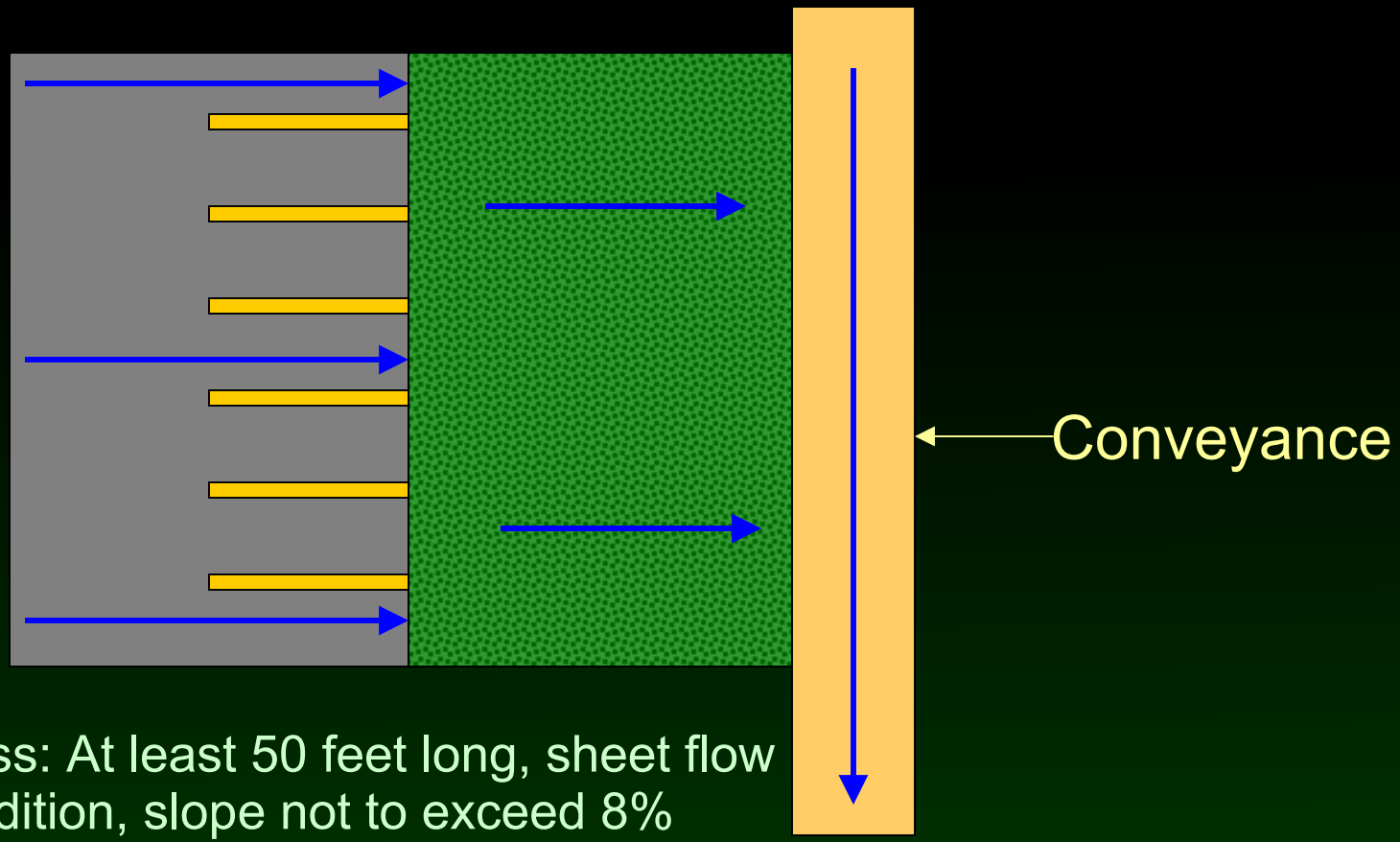
Interim Guidelines for Other Surfaces

- Source area flow length may not exceed 75 feet
- Source area and pervious area must be graded for sheet flow
- Pervious area must be:
  - In good condition, not to exceed 8% slope
  - Have a flow length at least as long as the contributing impervious area (but never less than 20 feet)

Residential Rooftop Disconnection

Parking Lot Disconnection

If Parking Lot: 50 feet long (must have sheet flow)



Then grass: At least 50 feet long, sheet flow good condition, slope not to exceed 8%

Exclusions

- Based on *groundwater quality protection*
- Two categories of exclusions
  - Based on land uses & source areas:
    - Industrial sites; fueling & vehicle maintenance
  - Based on site restriction for infiltration devices
    - proximity to karst features or water supply wells; high groundwater; contaminated soils; soils with inadequate pollutant attenuation based on depth and % fines

Using Exclusions

- We do not want to see infiltration of runoff from listed source areas.
- We do not want to see infiltration devices located at excluded infiltration sites.

Using Exclusions

- The rule does not prohibit infiltration from source areas or at locations identified in this part of the rule, but infiltration may not be credited towards meeting the standard.

- Remember: Discharges from all infiltration systems must protect groundwater.

Expectation for Groundwater Protection

- Minimize pollutants reaching groundwater
- Maintain compliance with PAL
- Discharge from BMP shall remain below ES
- DNR Conservation Practice standards should meet groundwater protection requirements

Exemptions

- Based on *feasibility*
- Two categories of exemptions
  - Based on land uses & source areas:
    - Small parking areas & access roads; redevelopment sites; small in-fill sites; roads/arterial roads in specified areas
  - Based on site restriction for infiltration devices
    - Measured soil infiltration rate less than 0.6”/hr
    - Infiltration when soil is frozen

Using Exemptions

- The rule does not require infiltration from source areas or at locations identified in this part of the rule

- A developer may choose to infiltrate exempted runoff. If this water is infiltrated, DNR will give credit towards the infiltration goal.

Using Exemptions

- Exempted source areas do not affect the calculation of the maximum required effective infiltration area (cap)

- Runoff from exempted source areas does not have to be included in calculating the infiltration goal, but BMP design should take it into account to assure the device can safely handle the flow

Compensation

- If you can't infiltrate because of a "site-based" exemption or exclusion you must attempt to infiltrate an equivalent volume elsewhere, to the maximum extent practicable.

- Examples:
  - Exemptions: Tight soils (0.6 inches/hour)
  - Exclusions: High groundwater, shallow bedrock, percent fines, distance to wells

Pre-Treatment

- Goals:
  - Reduce clogging of infiltration BMP
  - Reduce groundwater contamination
- Pre-treat runoff from:
  - All parking lots
  - New roads in non-residential areas
- Not required for roof runoff

Pre-Treatment

The required level of pre-treatment
is specified in each
DNR Conservation Practice Standard

Pre-treatment Example

Design and Construction of a Stormwater Infiltration Basin in Monona, Wisconsin

Bernard Michaud, P.E., P.H.
Earth Tech, Madison, WI
for Horizon Construction Group LLC

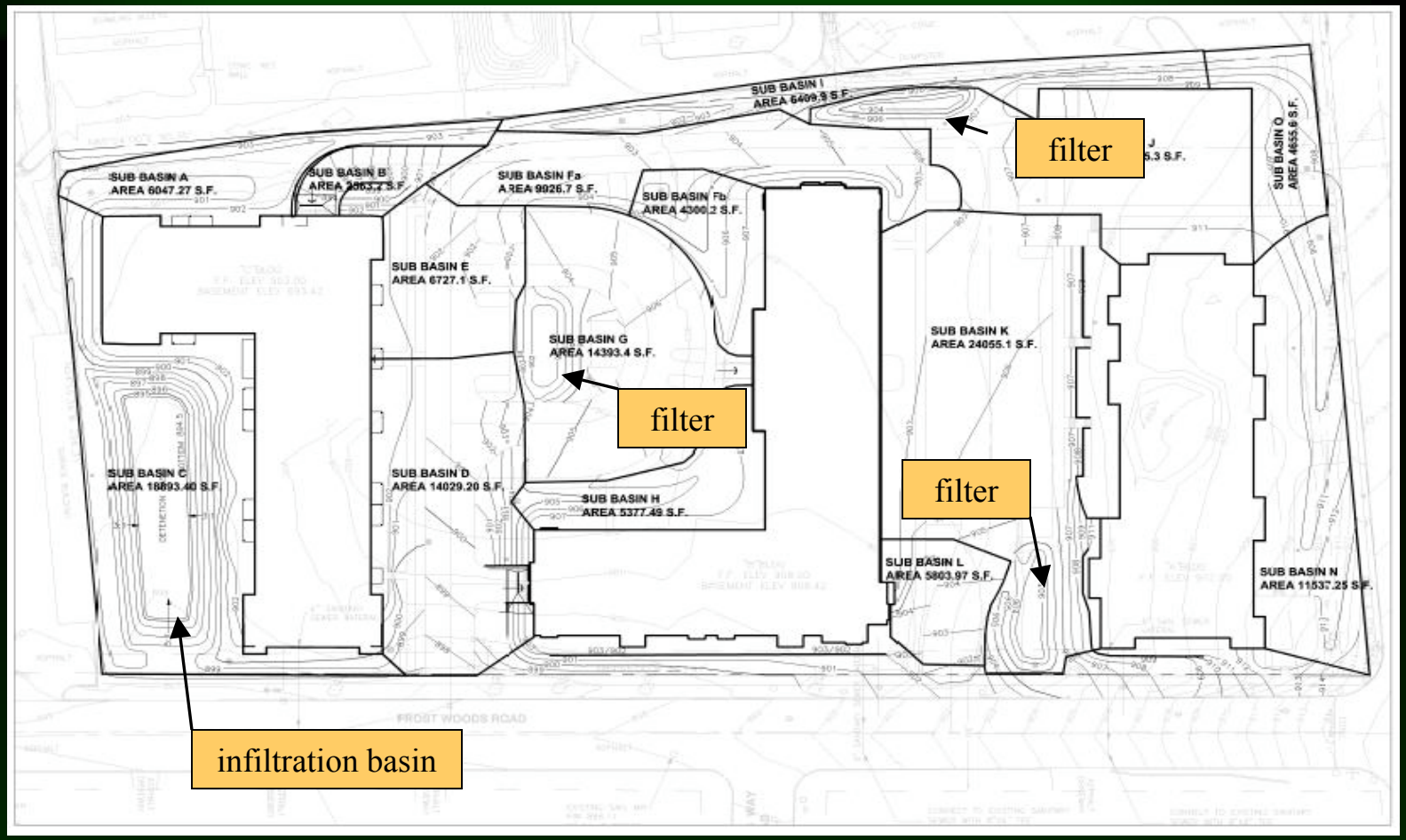
Design Criteria for the Stormwater Infiltration Basin

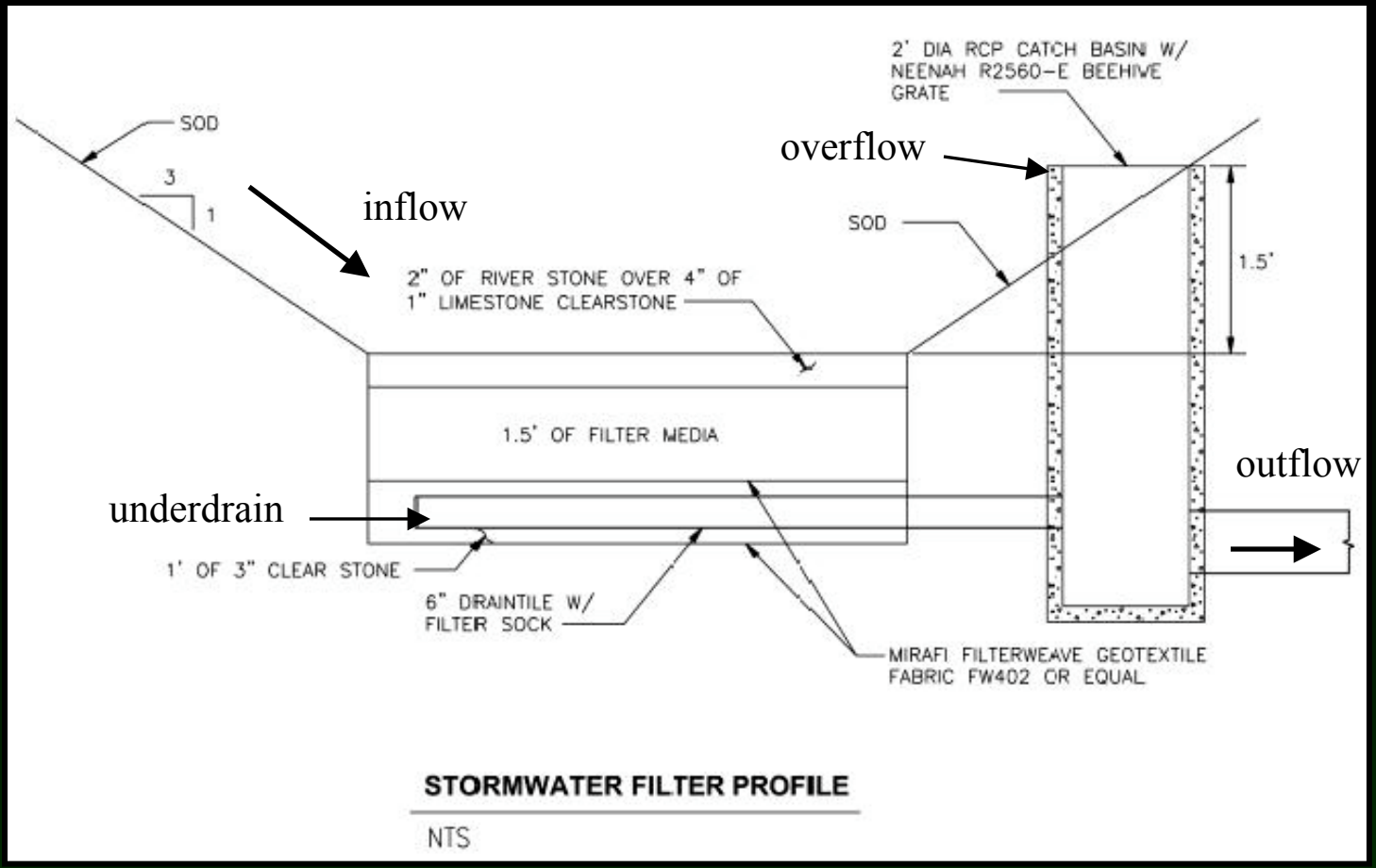
- Provide stormwater pretreatment
- Provide groundwater protection
- Design infiltration rates
- Meet City of Monona infiltration volume goal
- Avoid groundwater mounding

Stormwater Pre-treatment

- 80% sediment reduction from 1-yr, 24-hr storm (2.2” rainfall).
- Standpipe overflows for larger storms.
- Rooftop runoff is not filtered.
- Filter media:
  - 50% torpedo sand,
  - 25% screened leaf compost, and
  - 25% sandy loam

Frost Woods Commons Site Plan




2' DIA RCP CATCH BASIN W/
NEENAH R2560-E BEEHIVE
GRATE
SOD
3
1
inflow
overflow
SOD
1.5'
2" OF RIVER STONE OVER 4" OF
1" LIMESTONE CLEARSTONE
1.5' OF FILTER MEDIA
outflow
underdrain
1' OF 3" CLEAR STONE
6" DRAINTILE W/
FILTER SOCK
MIRAFI FILTERWEAVE GEOTEXTILE
FABRIC FW402 OR EQUAL
STORMWATER FILTER PROFILE
NTS

Filter 3 Completed

Grasses on Infiltration Basin

Alternative Use of Runoff

- The volume of runoff used for alternative purposes will be credited towards the infiltration requirement
- Alternative uses include:
  - Toilet Flushing
  - Laundry
  - Irrigation

Questions?